

## Case Study: A Geographic Information System (GIS) as a Tool for First Nations Housing Management, Planning and Safety

### INTRODUCTION

Solving problems is easier when relevant information about the problem is well-organized and tools are available for analysis. When the problem involves community planning and the analysis involves spatial thinking, one of the best tools is a Geographic Information System (GIS).

A GIS is a computer-based tool that combines the organizing power of databases with the intuitive understanding that comes with visual display, usually in the form of maps.

The GIS stores information about things (objects) that have geographical references. Within the GIS, the database component is used to modify or analyze the information while the visual display depicts the object with other geographical features on a computer-generated map.

Perhaps the single most important characteristic of a GIS is the linking of visual objects on the map to records in the database. The linking makes it possible to retrieve information from the database by clicking on objects on the map.

Maps are usually made up of many layers, with each type of object placed on its own layer. GIS allows a user to switch off the layers that are unrelated to the user's task. This makes it possible to see patterns and relationships that would otherwise be lost in the confusion of having too much information. Layers can also contain background images, such as those from a satellite or an air photo.

Many community planning questions have a strong visual aspect to their solutions. Using GIS for planning is common in larger communities in Canada. In smaller communities, which include most First Nations, it is much less common. As communities increase in size and complexity—the situation of most First Nations—it becomes more difficult to make decisions without an information system such as GIS.

The Cree Nation of Mistissini, one of the James Bay Cree First Nations in northern Quebec, was an early adopter of GIS for community needs. Unlike most other First Nations, which have focused on GIS for forestry and natural resource management, the Cree Nation of Mistissini uses GIS for community planning, including housing, infrastructure and public safety.

This *Research Highlight* summarizes a case study of implementation and ongoing use of GIS in Mistissini.

### Location and Community Details

The Cree Nation of Mistissini is about 90 km (56 m) north of Chibougamau in north-central Quebec, near the southern end of Lake Mistassini, at latitude 50° 25' N, longitude 73° 53' W.

The community grew around a former Hudson's Bay post and there has been a noticeable community presence since the 1930s.

The current population is around 3,600 and is growing quite rapidly. The community has mostly paved roads, well-developed sewer and water infrastructure, fire hydrants, street lights and its own fire and police services using Cree officers.

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Mistissini has a variety of housing styles and models, ranging from mobile homes to a 12-unit, multi-family residence. Most homes are single-family units, although three- and four-unit rowhouses are becoming popular. There is a good mix of public, rent-to-own and private homes in the community. The community has added more than 100 houses in the last two years.

#### Objectives

The case study's main objective was to tell the story of how GIS developed in Mistissini and how it is used in the day-to-day management of the community.

The second objective was to show communities that do not have GIS how information can be organized and maintained so it can be incorporated into a GIS. This was illustrated by comparing the information approaches in four of the other eight communities of the James Bay Cree—Waswanipi, Ouje-Bougoumou, Wemindji and Eastmain.

The third objective was to show what administrative reporting about housing and public safety is being done with the help of GIS outputs.

#### Methodology

A case study approach was chosen, focusing mainly on the community of Mistissini, and to a lesser extent on the four other James Bay Cree communities. Permissions for the study were requested and received from all the communities.

Key informants were identified and interviewed. Questions covered the historical development of the communities' information systems and examples of how the communities use their systems. Responses and observations were compared and evaluated against a hierarchy of computer-based applications for recording and manipulation of data—GIS, database, spreadsheet and word-processor (lists and tables). The final report was returned to the communities for comment.

## FINDINGS

#### Historical development

GIS requires a fairly powerful computer, software, maps or raw spatial information to make maps, and a person with GIS skills. Two important influences on Mistissini's adoption of GIS were:

1. The availability of information, at no cost to the community, in the form of air photos and digital map files provided by the federal government every five years as part of the James Bay Agreement.

2. The interest and capability of a community member who already had GIS skills and formal GIS training.

Mistissini has had a GIS technician and GIS capabilities for community mapping for over 10 years. The GIS technician is a community member who was trained at a CEGEP (Quebec community college) in GIS theory and the use of GIS software. He has added to his formal CEGEP training with vendor courses and other training.

The GIS technician has been through several GIS software upgrades and upgrading of computer equipment. He has recently taken on the position of local land registrar and is responsible for land registration in the community.

In 2006, a second community member, who graduated from the GIS program at Sir Sanford Fleming College in Peterborough, Ont., assisted in mapping projects.

The Cree Nation of Mistissini has invested considerable funds in GIS software, training, computers, printers, office space and supplies. The GIS technician uses a well-equipped computer with two screens that allow him to increase his computer work area. The computer is on a network, which allows the technician to transfer information to other users and obtain data from others in the community.

The technician also has full Internet access and several different format colour inkjet printers and black and white laser printers.

One colour printer is large format (24-inches wide by up to the 100-foot length of a paper roll) that can easily print the larger map sheets required for more detailed community needs. There is a second colour printer that supports tabloid (11" x 17"), legal (8.5" x 14") and letter (8.5" x 11") formats.

The colour printers are useful for printing colour maps created using GIS. The black and white laser printers are cost-effective for printing small maps and reports with tabular and statistical data.

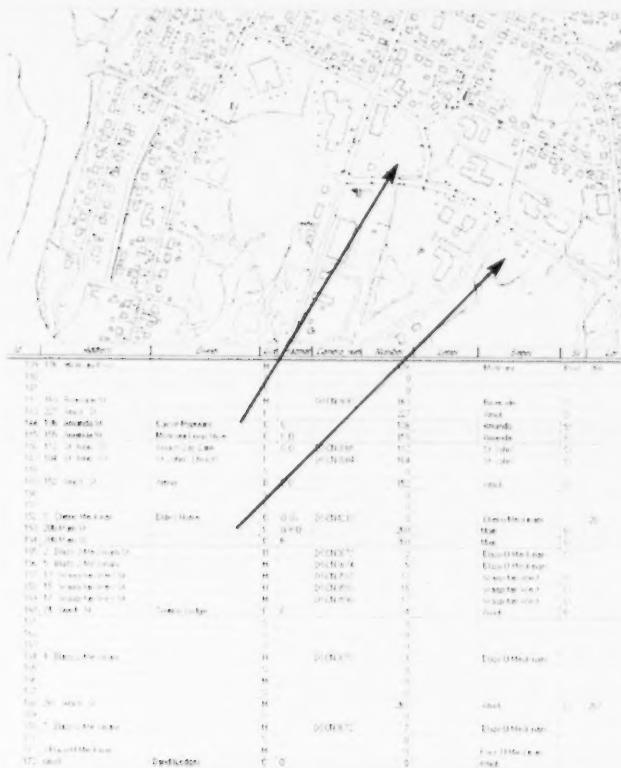
Although costly, there are downstream savings associated with the investment in the printers. The community does not have to hire an outside consultant and does not have to send maps south for printing. These savings pay for the printers and supplies.

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## Current usage

New information on developments in the community is added when it becomes available. Apart from location, the associated information may be quantitative or qualitative, such as specifications or photo images. It may also be another map from a government source.

The GIS is used to generate regular reports and maps so that there are always reasonably up-to-date plans and descriptions of the community infrastructure. Quarterly updates include items such as hydrant locations, new roads, lots and houses. Annual updates include residential information, such as age and area of house, builder and owner.



**Figure 1** A small example of the GIS information available for Mistissini. A portion of the map and information from the database on selected commercial properties are shown. Roads, buildings, contours, shorelines, drainage and vegetation are shown in more detail at a variety of scales and with more information than could be found on a paper map.

The GIS is frequently used to produce customized maps and reports. It is simple to produce digital or paper maps on demand at the required scale and size, or to transform maps by changing scale, joining or splitting maps. A variety of users receive digital information from the GIS to use in their own database or spreadsheet applications, or simply to incorporate in slide presentations.

Up-to-date maps are useful in dealing with different levels of government as well as private companies that may be hired for planning, paving, building, maintenance or other work in the community. The community can use the maps to make clear what work is required and where the work is to be done. Planning time is decreased as maps and information are immediately available.

Mistissini housing initiatives include homeownership and home renovations. Potential private homeowners in Mistissini use the information from a GIS map along with lot dimensions from a survey to review and choose a lot. The GIS is also used to distribute cottage lots in the area surrounding the community.



**Figure 2** The sort of GIS map that would be used by the Mistissini Housing Department in planning its renovation work. Each home in the designated renovation zone would have a list of needed repairs, required materials and project scheduling information available just by clicking.

Renovations need to be supported by photos, written reports and a map of the area showing the houses scheduled for renovation. Staff in the housing department use GIS files that have been prepared for them specifically so that they can print their own maps at the scale and for the areas that they require on an as-needed basis. These maps show the exact area, house footprints, road access and other details that are required to support renovation plans.

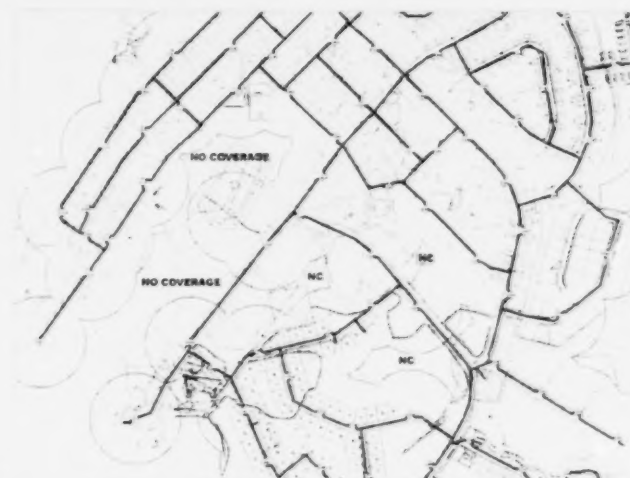
The GIS maps can be used to record differences in location between the plans as-drawn and as-built for buildings, water infrastructure and roads. Recording such differences as soon as possible can save a lot of heartache later. For example, differences in road allowances or road intersections could have a detrimental effect on lot accessibility and providing lot services if not recorded.



**Figure 3** A GIS map of an expanding area of Mississauga. New residential lots are in the upper left of the map, and planned roads and the water and hydrant infrastructure are in the lower right.

The layers most used by Mississauga's departments of housing and public safety are:

- The layer covering all buildings.  
This includes private homes, community buildings, government buildings, schools and other buildings. Ownership of all buildings can be determined, quantified and mapped using the GIS. Information about house size (area or number of rooms), age and model number/builder can also be identified as long as the information is in the database. A complete database of home information and addresses is attached to the map and can be easily accessed.
- The water infrastructure layer.  
This includes potable water, hydrants, valves, storm and sanitary sewers. GIS maps are useful to staff for field inspections and maintenance. For fire safety, the GIS can measure the distance from fire hydrants to homes and buildings. This ensures that fire hydrants are evenly distributed and tells the fire department where longer hose lengths are required.
- The layers covering rivers, lake shorelines and islands.  
These are useful for planning water infrastructure installation or expansion. This information helps to ensure that sewage outlets or drainage channels are not located too close to potable water intakes.



**Figure 4** The existing fire hydrant network. The effective range of fire hoses in Mississauga is 100 metres and this is shown in the GIS-created buffer zones around each hydrant. When the zones are blended, the overall coverage is seen to be very good with few gaps.

- The contour and spot height layers.  
Useful for planning purposes in terms of community layout to minimize costly excavation and provide reasonable slopes for buildings and roads.
- The vegetation and tree canopy layers.  
Useful for planning. All conditions being equal, in terms of soil and slope, etc., it is easier to build on land with fewer trees. Trees can also be used to provide windbreaks and noise barriers.
- Hazardous material or site layers.  
These layers are becoming more important as more hazardous materials are coming into communities in the form of medical products (for clinics, older people's homes and rehabilitation centres), cleaning products (schools, offices and some businesses) or other hazardous materials (maintenance garages, gas stations, aircraft refuelling areas, propane storage, etc.). The information is very useful for fire and public safety. Knowledge of hazardous sites can be useful for planning and budgeting. Mississauga has made a preliminary community assessment of hazardous materials.

### In Development

The information attached to the GIS map layers is growing. The most recent layer was water infrastructure, courtesy of the Cree Regional Authority (CRA) mapping project. Hydrant, valve and water line information will be gathered during 2007. The information added to the database attached to the water maps will give equipment specifications and record completed and required maintenance and repairs. Similar information will be collected and maintained for the community's storm and sanitary sewer infrastructure.

Several additions to the non-map aspects of the community GIS are in the early stages of planning or data collection. A digital photo has been taken of each house and building in the community. These photos will be linked to the community map and database so users can click on a building on the map and see a photo of the building. Home plans for the various models of homes in the community have been scanned and will be linked in the same way.

Under consideration is the addition of more detailed information for the hazardous material map and associated database. This would include specific hazards in various buildings or specific sites, such as the old generator station and fuel storage facility.

### Organization of other Communities' Data

The case study also looked briefly at four of the eight other James Bay Cree communities that do not have a GIS. The focus was on how their organization of information compared with the GIS approach of Mistissini.

They all had some degree of organized information using other software, such as word processing (lists and tables), graphics and spreadsheet programs. Of particular note for housing, all four communities had implemented or were in the process of implementing a customized database program for housing that has been developed by the Cree Regional Authority. Databases are particularly well-suited for incorporation into a GIS.

### CONCLUSIONS

Two factors led to Mistissini's adoption of GIS. The first was the availability of free geographic information. The second was the presence in the community of an individual with GIS skills. It seems unlikely that the GIS initiative would have occurred without such a happy coincidence. While the free information is a considerable benefit, other James Bay Cree communities that also had access to it did not adopt a GIS approach.

The constant support of the Board of Directors of the Cree Nation of Mistissini over 10 years has allowed the GIS function to grow. It now plays an active role in the running of the community. GIS maps and reports assist staff in the departments dealing with housing, operations and maintenance, public safety, recreation and tourism. It is an effective communication tool for change in the community and GIS maps are regularly posted in public places.

Another factor in the growth of the GIS function is the existence of governance at the Cree Regional level. Institutions, such as the Cree Regional Authority (with technical and information responsibilities) that operate at a higher level of governance with a greater span of control, see advantages of consistently well-organized information earlier than local governments.

Availability of GIS provides an incentive for skills acquisition by decision-makers outside the GIS department. In Mistissini, training has been provided to senior management in GIS capabilities and use in the community, along with instruction in creating simple maps. At least one community member is interested enough in GIS to pursue college education in the field in anticipation of employment with his community or another Cree Nation or agency.

All First Nations in this case study appear to have enough computer capacity and familiarity with software to capture and organize information.

First Nations could improve this existing capacity with better organization and backing up of files. The benefit of preparing and standardizing data for discussions with various levels of government or for working with outside contractors and consultants is worth doing whether there is a longer-term objective of setting up in-house GIS. Organized information makes it easier to respond to requests for information, generation of statistics and record-keeping. Linked databases allow for more information to be searched and queried.

## Research Highlight

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